

14       an insulation stack with a coil layer embedded therein located between the first and second  
15       pole piece layers wherein the insulation stack includes at least one baked photoresist insulation  
16       layer that has been formed in part by heating at a preselected annealing temperature in the presence  
17       of a magnetic field that is directed perpendicular to said ABS;  
18

19       the insulation stack having been formed subsequent to said sensor and at least the first pole  
20       piece layer having not been subjected to annealing in the presence of a magnetic field directed  
parallel to said ABS before said heating of the layer of the insulation stack; and

21       at least one of the first and second shield layers and the first and second pole piece layers  
22       comprising NiFeCo-O-N or NiFeCo-N.

1           2. A magnetic head assembly as described in claim 1 wherein the second shield layer and  
2       the first pole piece layer are a common layer.

1           2           3. A magnetic head assembly as described in claim 1 wherein the second shield layer and  
2       the first pole piece layer are separate layers and are separated by a nonmagnetic insulative isolation  
3       layer.

1           2           4. A magnetic head assembly as described in claim 1 wherein the second shield layer  
comprises NiFeCo-N.

1           2           5. A magnetic head assembly as described in claim 1 wherein the second pole piece layer  
comprises a laminated layer of NiFeCo-O-N films with interlayer films of Al<sub>2</sub>O<sub>3</sub> or SiO<sub>2</sub>.

1           2           3           4           5           6. A magnetic head assembly as described in claim 5 including:  
a seed layer comprising NiFeCo-O-N;  
the second pole piece layer being directly on the seed layer; and  
the seed layer having higher O and N contents than the NiFeCo-O-N of the second pole  
piece layer.

1           2           3           7. A magnetic head assembly as described in claim 6 including:  
a bottom layer of SiO<sub>2</sub>; and  
the seed layer being located between the bottom layer and the second shield layer.

1           8. A magnetic head assembly as described in claim 7 wherein the laminated layer includes  
2 four NiFeCo-O-N films that are each substantially 4500 Å thick.

1           9. A magnetic head assembly as described in claim 8 wherein the second shield layer  
2 comprises NiFeCo-N.

1           10. A magnetic disk drive including a magnetic head assembly having an air bearing  
2 surface (ABS), the disk drive comprising:

3           the magnetic head assembly including:

4           a spin valve sensor, first and second nonmagnetic first and second read gap layers,  
5 a ferromagnetic first shield layer and a ferromagnetic first pole piece layer;

6           the spin valve sensor being located between the first and second read gap layers  
7 and the first and second read gap layers being located between the first shield layer and the  
8 first pole piece layer;

9           the spin valve sensor having a pinned layer which has a magnetic moment that is  
10 pinned by a pinning layer in a direction perpendicular to the ABS;

11           a ferromagnetic second pole piece layer and a write gap layer wherein the second  
12 pole piece layer is separated from the first pole piece layer by the write gap layer at the  
13 ABS and is connected to the first pole piece layer at a back gap;

14           each of the first shield layer and the first and second pole piece layers having an  
15 easy axis that is directed parallel to the ABS;

16           an insulation stack with a coil layer embedded therein located between the first and  
17 second pole piece layers wherein the insulation stack includes at least one baked  
18 photoresist insulation layer that has been formed in part by heating at a preselected  
19 annealing temperature in the presence of a magnetic field that is directed perpendicular to  
20 said ABS; and

21           the insulation stack having been formed subsequent to said sensor and at least the  
22 first pole piece layer having not been subjected to annealing in the presence of a magnetic  
23 field directed parallel to the ABS before said heating of the layer of the insulation stack;  
24 and

25           at least one of the first and second shield layers and the first and second pole piece  
26 layers comprising NiFeCo-O-N or NiFeCo-N;

27           a housing;  
28           a magnetic disk rotatably supported in the housing;  
29           a support mounted in the housing for supporting the magnetic head with its ABS site facing  
30       the magnetic disk so that the magnetic head is in a transducing relationship with the magnetic disk;  
31           spindle motor for rotating the magnetic disk;  
32           an actuator means connected to the support for moving the magnetic head to multiple  
33       positions with respect to said magnetic disk; and  
34           a processor connected to the magnetic head, to the spindle motor and to the actuator for  
35       exchanging signals with the magnetic head, for controlling movement of the magnetic disk and  
36       for controlling the position of the magnetic head.

1           11. A magnetic disk drive as described in claim 10 wherein the second shield layer and  
2       the first pole piece layer are a common layer.

1           12. A magnetic disk drive as described in claim 10 wherein the second shield layer and  
2       the first pole piece layer are separate layers and are separated by a nonmagnetic insulative isolation  
3       layer.

1           13. A magnetic disk drive as described in claim 10 wherein the second shield layer  
2       comprises NiFeCo-N.

1           14. A magnetic disk drive as described in claim 10 wherein the second pole piece layer  
2       comprises a laminated layer of NiFeCo-O-N films with interlayer films of Al<sub>2</sub>O<sub>3</sub> or SiO<sub>2</sub>.

1           15. A magnetic disk drive as described in claim 14 including:  
2           a seed layer comprising NiFeCo-O-N;  
3           the second pole piece layer being directly on the seed layer; and  
4           the seed layer having higher O<sub>2</sub> and N<sub>2</sub> contents than the NiFeCo-O-N of the second pole  
5       piece layer.

1           16. A magnetic disk drive as described in claim 15 including:  
2           a bottom layer of SiO<sub>2</sub>; and  
3           the seed layer being located between the bottom layer and the second shield layer.

1           17. A magnetic disk drive as described in claim 16 wherein the laminated layer includes  
2 four NiFeCo-O-N films that are each substantially 4500 Å thick.

1           18. A magnetic disk drive as described in claim 17 wherein the second shield layer  
2 comprises NiFeCo-N.

1           19. A method of making a magnetic layer with in-plane anisotropy and high H<sub>K</sub> after hard  
2 axis annealing in the presence of a field perpendicular to the plane comprising the steps of:

3           providing a DC magnetron which has a chamber, a target and a substrate;  
4           the target being NiFeCo;

5           providing a first process gas in the chamber which is composed of an inert gas and a  
6 nitrogen containing gas; and

7           sputtering the target to form said magnetic layer composed of NiFeCo-O-N or NiFeCo-N  
8 on the substrate.

1           20. A method as described in claim 19 wherein no bias is applied to the substrate.

1           21. A method as described in claim 19 wherein the first process gas includes 1.6% to  
2 3.2% N<sub>2</sub>O and the magnetic layer includes multiple sputtered NiFeCo-O-N or NiFeCo-N films.

1           22. A method as described in claim 19 wherein the first process gas includes 1.6% to 3.2%  
2 N<sub>2</sub>O and the magnetic layer is a single film 2,500 Å to 6,000 Å thick.

1           23. A method as described in claim 19 wherein the first process gas includes 1.0% to  
2 2.0% N<sub>2</sub> and the magnetic layer is a single film 4,500 Å to 18,000 Å thick.

1           24. A method as described in claim 19 wherein the target is (Ni<sub>0.80+x</sub>Fe<sub>0.20-x</sub>)<sub>1-y</sub>Co<sub>y</sub> where  
2 -0.05 ≤ x ≤ 0.05 and 0.00 ≤ y ≤ 0.15 (wt. fraction).

1           25. A method as described in claim 19 wherein the first process gas is said inert gas and  
2 N<sub>2</sub> and the target is sputtered to form the magnetic layer of at least a single film of NiFeCo-N  
3 about 1.8 μm thick.

1           26. A method as described in claim 25 wherein the first process gas includes 1.0% to  
2           2.0% N<sub>2</sub>.

1           27. A method as described in claim 26 wherein during sputtering the first target, a  
2           pressure between 1 x 10<sup>-3</sup> to 3 x 10<sup>-3</sup> is maintained within said chamber and the magnetic layer  
3           comprises one or more films of NiFeCo-N from 4,500 Å to 18,000 Å thick.

1           28. A method as described in claim 19 including:  
2           the first process gas being said inert gas and N<sub>2</sub>O;  
3           sputter depositing multiple interlayer films of Al<sub>2</sub>O<sub>3</sub> or SiO<sub>2</sub>; and  
4           sputtering the target multiple times to deposit multiple NiFeCo-O-N magnetic films;  
5           and alternating the depositions to form the magnetic layer as a lamination of magnetic and  
6           interlayer films.  
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1           29. A method as described in claim 28 including:  
2           hard axis annealing the magnetic layer at about 232° C in the presence of magnetic field  
3           perpendicular to a major plane of the magnetic layer for about 400 minutes; and  
4           after said hard axis annealing, the magnetic layer having an H<sub>K</sub> from 2.6 Oe to 6.0 Oe and  
5           in plane anisotropy.

1           30. A method as described in claim 28 wherein the first process gas includes 1.6% to  
2           3.2% N<sub>2</sub>O and each of the NiFeCo-O-N films is about 4,500 Å thick.

1           31. A method as described in claim 28 wherein no bias is applied to the substrate.

1           32. A method as described in claim 28 wherein before sputtering the target, sputter  
2           depositing a seed layer of NiFeCo-O-N with a second process gas that has a higher N<sub>2</sub>O content  
3           than the first process gas.

1           33. A method as described in claim 32 wherein the seed layer is 25 Å to 200 Å thick.